# New Developments in the Hydrogen Maser Frequency Standard

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*Measurements have been made on the JPL hydrogen masers to determine the average fractional frequency departure versus averaging time. In addition, the receiver section has been modified with a newly developed frequency synthesizer.*

## I. Introduction

Recently measurements have been made to determine the frequency stability of the new JPL hydrogen masers. In addition, the old receiver–synthesizer section has been modified with a newly developed frequency synthesizer which will not only improve the performance and reliability of the receiver, but also decrease its size and complexity.

This article is a continuation of the articles relating to the hydrogen maser development found in Refs. 1 to 3.

## II. Measurement of Frequency Stability

Figure 1 is a plot of the standard deviation of the average fractional frequency departure versus averaging time for two masers. With the power output of the two masers at −85 and −89 dBmW, the measured short-term stability approaches the theoretical limit predicted by Cutler and Searle (Ref. 4).

## III. Receiver-Synthesizer Developments

A new low-drift frequency synthesizer is being built in conjunction with Dana Laboratories which will provide the maser with a frequency settability of 7 parts in $10^{-18}$. Its frequency range will be 400 to 510 kHz in steps of $10^{-8}$ Hz. The synthesizer, when subjected to temperature steps of 25°C, was found to have a maximum drift rate of $0.3 \times 10^{-3}$ degrees of phase/second at 50 MHz which corresponds to a frequency stability of 1.6 parts in $10^{-14}$. This is two orders of magnitude improvement over present units and enables the synthesizer to achieve $10^{-8}$ Hz resolution. A diagram of the new receiver is shown in Fig. 2. The synthesizer is driven directly from the 100-MHz signal at the output of the 100-MHz distribution amplifier. Output frequencies from the new maser receiver will be 100 MHz, 10 MHz, 5 MHz, 1 MHz, and 100 kHz.

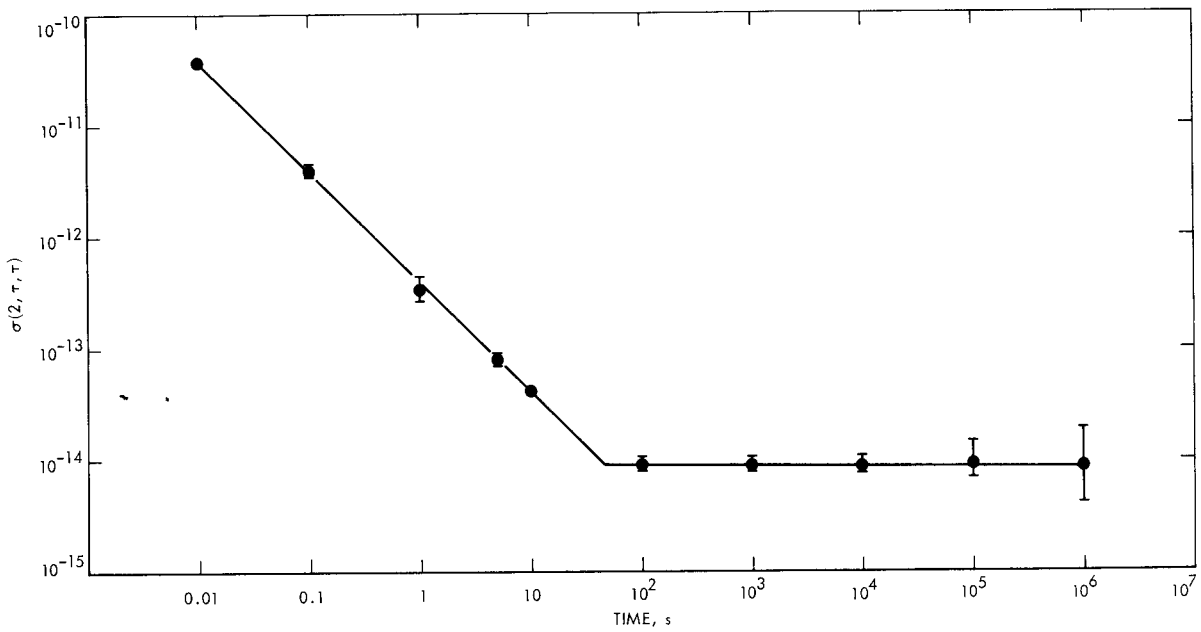


**Fig. 1. JPL hydrogen maser frequency stability**

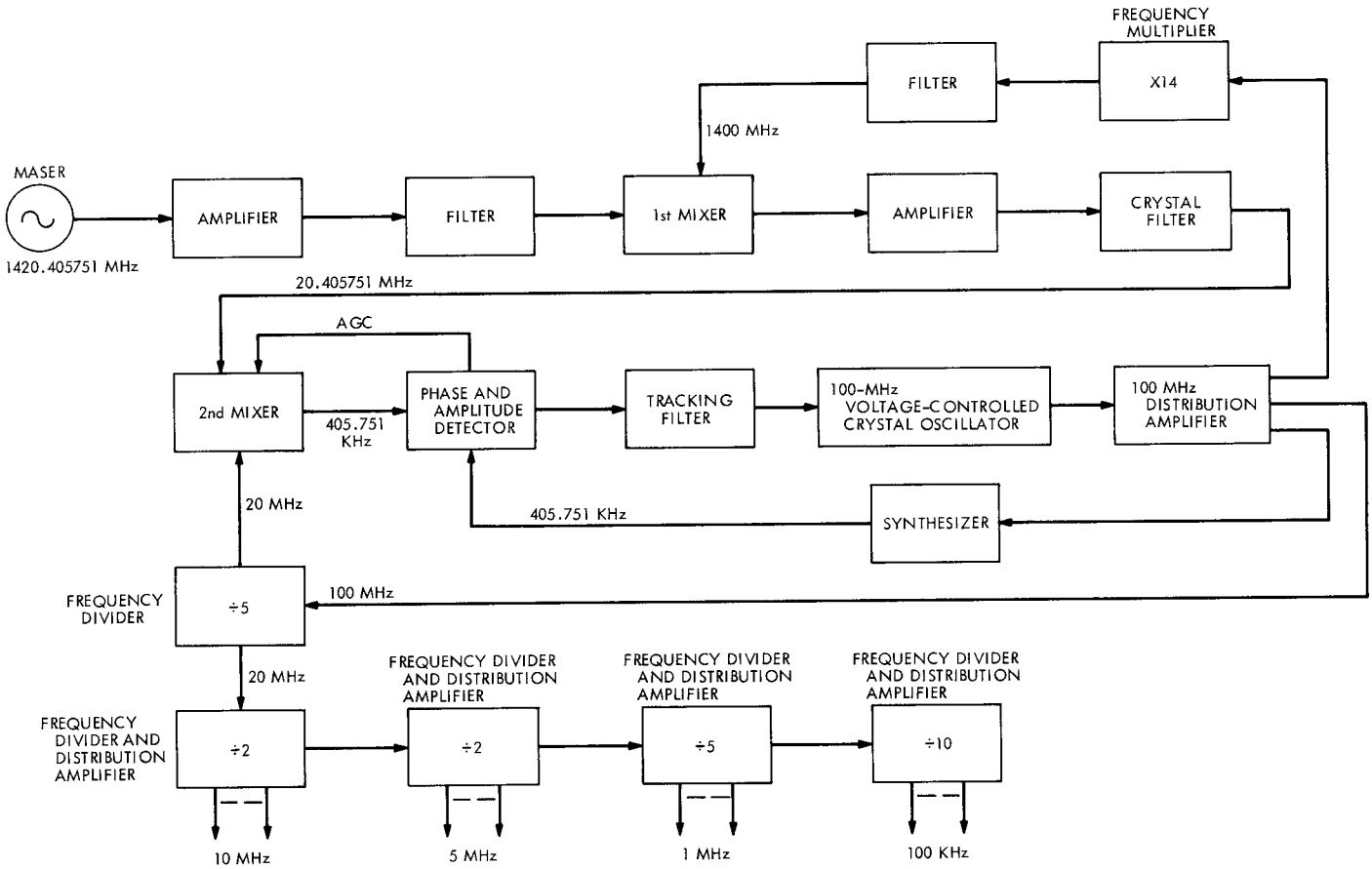


**Fig. 2. Hydrogen maser receiver-synthesizer**

## References


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3. Lutes, G., "Frequency Generation and Control: Distribution Amplifiers for the Hydrogen Maser Frequency Standard," in *The Deep Space Network*, Space Programs Summary 37-61, Vol. II, pp. 68–72. Jet Propulsion Laboratory, Pasadena, Calif., Jan. 31, 1970.

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